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The effect of delay cultivation on dry matter accumulation and chickpea yield in dry land conditions

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Key words: Chickpea, fall cultivation, spring cultivation, drought stress, dry matter accumulation, yield component and grain yield.

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Abstract

Plant yield as a result of the allocation of the photosynthesis material to economic organs is that was obtained through balanced relationships between source and the tank. Exact and correct of physiological processes understanding of controlling yield and proper use of them will be caused to increase crop plants yield. In this case the experiment was done in Islamic Azad University of Kermanshah in 2011. In this study, three cultivars of chickpea such as Flip93-93, 12-60-31 and Hashem in three planting dates such as fall, expended and spring (delay) were compared with complete random blocks factorial in 4 repetitions. Growth indicators such as: total dry matter (TDM), stem dry matter accumulation (SDM), leaf dry matter accumulation (LDM), pod dry matter accumulation (PDM) and grain dry matter accumulation (GDM) plant height, number of seeds per plant, 100-seed weight, biological yield, harvest index and grain yield were evaluated. Flip93-93 cultivar in fall cultivation had the highest dry matter accumulation of leaf, stem and the whole plant. Meanwhile Hashem cultivar had the least dry matter accumulation in all of the indexes. Reducing the dry matter accumulation in total plant in delay cultivation (spring) rather than fall cultivation in Flip93-93, 12-60-31 and Hashem in order, were 145, 23, and 47%, which show that superiority of fall cultivation rather than spring cultivation. Finally Flip93-93 cultivar in fall cultivation (1002.1 Kg/ha) had the highest and 12-60-31 cultivar in delay cultivation (336.52 Kg/ha) had the least seed yield.

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Introduction

For the purpose of determining the most suitable planting date to choose the best is when the set of environmental factors for the sprouting, conformation and plant survival provided. This action causes proper use of climatic factors such as temperature, humidity, day longitude and matching the flowering time with the appropriate temperature and premonition the plant of encountering biological and no biological stress (Sabbagh pour, 2008). In high and cold regions of Iran, chickpea cultivation in spring was done but the early and on time fall cultivation in dry land conditions will be caused the plant uses spring precipitation and dispels salient amount of water necessity of it, but in spring cultivation the spring production yield was reduced severely for the reason of reducing precipitations and plant encountering with heat and stress of the end of season (Kashiwagi *et al.,* 2006). Leaf harvest index increased to high amount of itself with delaying in spring cultivation and temperature effects, and reduced immediately. If the date of cultivation delays for there, the amount of leaf area index and also the leaf area duration will decrease too (Bagheri *et al.,* 2001). The lack of moisture in the flowering stage reduced the period of the flowering. Generative dry matter is depending on leaf area development and durability and water consumption. The lack of moisture was caused to decrease the generative dry matter, leaf area index and relative growth speed (Zhang *et al.,* 2000). Vaghar 2007; reported that, in the early growth period, the significant contribution of dry matter accumulated in leaf and stem, and the leaf contribution is more than stem. With delaying in cultivation, shoot dry weight due to shorten plant growth period reduced. After flowering, dry matter accumulation in stem didn't change, but in leaves due to material transfer and defoliation reduced. Berger *et al.*, (2006) they announced unlimited growth of plants such as chickpea being unfavorable environmental conditions had a high negative effect on the number of the pod. A significant positive correlation with the number of the seeds in per plant with the number of pods in the plant represents that the pods for the reason of high photosynthesis material production developed faster, would produce abundance pods. Naturally, these bushes with the production of the photosynthesis material in the same environmental conditions of prevent the abortive plant. The chickpea tolerates the drought stress of the end of the season when flowering and seed growth beginning and decreases the seed yield 67 percent. Also announced that the pods that were produced late had the least seed weight due to the sever competition between them and the humid and temperature accent. So late cultivar that the period of grain filling deal with the heat of late spring has fewer seeds so that the number of pods and seeds in surface unit have relationship with the total dry matter production and the time of dryness occurrence (Leport *et al.,* 2006). Ranganathan *et al.* (2001) said the production of dry matter reduced approximately 24.2 kg/ha for per day delay. The delay in the chickpea growth affected on vegetative and reproductive growth, and reduced the amount of dry matter that produced in per Hectare. Ozdemir and Karadavut, (2003) during the experiment were announced that delay at the time of cultivation and drought stress (heat) at grain filling stage, reduced seed yield. Increasing the temperature will be reduced of the grain filling period and this was leaded to reduce the seed weight. The temperature of 35.16 °C for 10 days at the pod stage was leaded to reduce the seed yield from 53 to 59 percent in different chickpea genotypes (wang *et al.,* 2006). The average increasing yield in spring cultivation rather than fall cultivation was 212 percent (Pezeshkpour and Mirzaei-Heydari, 2004).

Materials and methods

Site description and soil analysis

This experiment was done in agricultural research farm in, Islamic Azad University of Kermanshah in 2011-2012. The longitude of this experiment was 34 degrees and 23 minutes north, the latitude was 47 degrees 16 minutes east, and the height of it from sea level, was 1351 m. Cold semi-arid climate of experiment region has a mean temperature of 15.2 °C and the maximum and minimum temperature respectively 41.9 and -11.2 °C in August and February. Total annual precipitation 368 mm which was the highest precipitation in May and the least occurred in June, July and August (Fig1). For determining of physical and chemical features of soil sampled from 0-30 Cm depth of experiment soil that its results are presented in Table 1.

Treatments and experimental design

The experiment was done in factorial shape in randomized complete blocks design in 4 reparations. Cultivation dates of treatments were (November 10th, December 25th and March 26th) and cultivar treatments were (Flip93-93, 12-60-31 and Hashem). The length of each cultivation plot were 3m that had included 8 cultivation rows with 25 Cm distance and the distance of two plants from each other were 10 Cm. In the autumn of the year before doing the experiment, the mentioned farm was tillage by chisel plow in order to maintain and store moisture, and was disked for the purpose of clod shattering and sold uniformity of the field. Based on the soil analysis results (Table 2) and fertilizer advise, about 38 kg pure Net in ha and 90 kg/ha phosphate with the light disk were given to the earth and mixed with the soil. Then the farm by furrow opener came to bed. Before cultivation, seeds were fumigating by Benomil fungicide, cultivation was laid manually inside the furrow in 5- 6 Cm depth of soil. In each point, were laid two seeds for the purpose of enough germination and plant emergence confidence that after emergence would be reduced to a plant. Thinning and weed control actions were done two weeks after emergence in two turns.

Plant sampling and measuring

In order to dry matter accumulation changes process during the vegetative period, sampling after emergence and observing to internal period were done in all plots once in every 15 days. Sampling was done after removing two side lines and 50 Cm from the beginning and end of each plot in order to neutralize the marginal effects. In each sampling time from every experimental plots were sampled 5 plants, from the surface, that was each 0.125 m^2. The plants were cut by clippers in 50 Cm distance from previous sampling and 2 Cm from field and were put in labeled pockets and were sent to the laboratory for measurement. The samples were weighted and dried by breaking down stem, leaf and in the next stages pods and seeds in Avon for 48 hours at 72 °C. At the end of the agricultural season of every experimental plots were selected randomly 10 plants and were measured slightly morphological traits. As well as to determine the ultimate yield of the two lines in the middle of each plot after removing of 50 cm from the beginning and end of lines 1 m^2 area, all of its plants, were harvested. This harvest when was done that the pods were yellow and completely dried at this time and grain moisture was 14%. Grains were separated from pods by harvester and then the grains were weighted by torsion balance.

Statistical analysis

Statistical data analysis was done by using the SAS software and comparing averages was done by Duncan at the level of 5% and drawing graphs was done by Excel software.

Results and discussion

Shoot dry matter (SDM)

At the beginning of the growth due to being small plants were produced little dry matter and by passing the time and growth continuance, the amount of dry matter shows the linear incremental process and after reaching at maximum value in flowering stage and the amount of it reduces. The dry matter accumulation rate of stem in delay cultivation decreased so that in all treatments cultivation produced the least and fall cultivation produced the most dry matter accumulation. The highest steam dry matter was observed at Flip93-93 in fall cultivation and the lowest was obtained in the delay cultivation of Hashem cultivar. Among the delay cultivations, 12-60-31 with the little difference rather Than Flip93-93 had the highest dry matter accumulation, that is related to plant early maturation and less plant encountering with drought tension of end of the season (Fig 2, 3). Reduction on of stem dry matter accumulation in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 66, 37 and 19 percent.

Leaf dry matter (LDM)

The results showed that the highest leaf dry matter accumulation speed obtained in Flip93-93 in fall cultivation (Fig 4). The fall cultivation rather than delay cultivation had the highest dry matter accumulation in the whole growth period. With growth, continuance leaf dry matter production showed the linear increscent but after flowering stage, the amount of dry matter had the reducing process at all treatments. This process in delay cultivation was done in higher intensity than fall cultivation. Vaghar, 2007 has reported similar results. The competition between vegetative and reproductive components for receiving the photosynthesis materials that effects on the end of the season stress, defoliation, storage materials transport to the pod and shortening the plant growth period. 12-60-31 in delay cultivation had the highest leaf dry matter accumulation rather than other cultivars. Also Flip93-93 with little difference had the less dry matter accumulation than Hashem (Fig 5). Dry matter accumulation process showed that 60 to 70 percent of the increscent in dry matter during the vegetative growth stage is related to leaf and petiole, and the remain of that related to yield components. Furthermore, the reduction of the leaf dry matter accumulation in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 48, 18 and 15 percent.

Table 1. Results of soil Physical and chemical properties of experimental location**.**

Sampling depth	pH	Ec dsm^{-1}	Organic matter (%)	Silt (%)	Clay (%)	Sand (%)	Total Nitrogen (%)	Available Phosphor mgkg^{-1}	Available Potassium mgkg^{-1}	Available Zinc mgkg^{-1}	Soil Texture
0-30	7.3	0.88	2.6	49.1	42.4	8.1	0.12	8.9	558	0.81	Silt Clay

Table 2. Analysis of variance for studied traits in chickpea.

		MS				
Source Of Variation (S.O.V)	df	Plant height (Cm)	100-Seed weight (gr/m^2)	Grain yield (Kg/ha)	Biological yield (Kg/ha)	Harvest Index (%)
Block	2	103.823	8.937	140.474	861.122	3.005
Variety	2	5.042 ^{ns}	3.898 ^{ns}	68.494 ^{ns}	1465.288 ^{ns}	200.853**
Sowing date	4	512.405**	36.227**	12666.798**	34751.828**	559.906**
Variety. Sowing date	8	57.426 ^{ns}	19.164*	74.927 ^{ns}	881.249 ^{ns}	8.795 ^{ns}
Error	28	21.570	5.115	187.182	783.052	16.428
(%) C.V	-	13.5	8.10	14.46	15.32	9.70

α ns: Non- significant, * and ** : Significant atα =0.05 & α =0.01, respectively.

Pod dry matter (PDM)

Changes in pod dry matter in different treatments had the same process so that the pods in fall cultivation had more dry matter. With delaying in spring cultivation (spring) the pod dry matter accumulation was reduced saliently 12-60-31 in fall cultivation had the most dry matter and the least dry matter was related to Hashem in delay cultivation (Figure 6, 7). As regards to chickpea is the indeterminate plant and the dry matter accumulation sample has the fast vegetative growth stage after flowering and in pod stage, we have the reducing process (Gangali and Nezami, 2008). Therefore, the availability of moisture on the flowering stage is very important because at this time the plant has an active vegetative growth. Reducing pod dry matter accumulation in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 31, 102 and 19 percent.

Grain dry matter (GDM)

Dry matter accumulation were effected on cultivation date so that fall cultivation had, the most and delay cultivation (spring) had the lowest grain dry matter accumulation. Parsa and Bagheri, (2008) Chickpea grain dry matter accumulation is also low in spring cultivation is related to shorten growth period and encounter with high temperature in the end of the spring. The most grain dry matter is related to Hashem cultivar in fall cultivation and the least grain dry matter is related to Flip93-93 in delay cultivation (Fig 8, 9). Reducing the grain dry matter accumulation in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively was 124, 120 and 107 percent.

Table 3. Mean comparison of studied traits in chickpea.

Factor	Mean: Plant height (Cm)	100-Seed weight (gr/m²)	Grain yield (Kg/ha)	Biological yield (Kg/ha)	Harvest Index (%)
Variety					
Flip93-93 (V1)	34.212 a	27.271 a	801.81 a	1737.2 a	44.652 a
12-60-31 (V2)	35.061 a	28.212 a	756.63 a	1950.1 a	37.103 b
Hashem (V3)	33.793 a	28.312 a	792.52 a	1791.3a	43.602 a
Sowing date	39.441 a	29.731 a	974.32 a	2134.1 a	45.952 a
Fall (D1)					
Winter (D2)	36.642 a	27.793 b	969.15 a	2139.3 a	45.501 a
Spring (D3)	26.983 b	26.271a	408.53b	1205.4 b	33.905 b
Variety. Sowing date					
V1D1	37.115 ab	31.612 a	1002.1 a	2056.1 a	48.684 ab
V1D2	36.354 b	26.582 b	977.82 a	1979.2 a	49.462 b
V1D3	29.152 cd	26.251 b	425.52 b	1176.3 b	35.821 d
V2D1	43.931 a	31.351 a	989.34 a	2335.3 a	42.281 bc
V2D2	38.335 ab	26.752 b	944.01 a	2371.2 a	39.405 cd
V2D3	22.931 d	26.122 b	336.52 b	1144.1 b	29.634 e
V3D1	37.282 ab	25.802 b	956.04 a	2089.2 a	46.139 ab
V3D2	35.224 bc	27.631 b	958.01 a	1991.2 a	48.421 ab
V3D3	28.883 cd	24.401 a	463.52 b	1294.2 b	36.262 cd

Similar letters in each column shows non- significant difference according to Duncan's Multiple Range Test in 0.05 levels.

Total dry matter accumulation (TDM)

The highest dry matter accumulation in fall cultivation was related to Flip93-93 with a small difference rather than 12-60-31 had the superiority. This cultivar due to more leaf area index had the enough opportunity to more dry matter accumulation. Among treatments, Hashem cultivar also had the lowest dry matter accumulation (Fig 11). Before the flowering stage, the plant growth is approximately slow, there wasn't significant difference among cultivars, but after flowering stage, the plant began the fast growth of itself, the differences among the treatments increased. This results match with the findings of (Singh, 1997; Rezaeyanzadeh, 2008). With delaying in cultivation (spring) due to the shortening of the growth period, competition increscent between vegetative and reproductive growth, the impact of the end of the season stress, reducing the plant soil water, reducing the active leaf level, reducing plant photosynthetic rate and reducing the material transfer efficacy to the grain were caused to less dry matter accumulation. Consequently, fall cultivation had the most, and delay cultivation had the least dry matter accumulation rate

(Fig 10, 11). Similar results were also reported by Mousavi *et al.,* (2009). Reducing the total plant dry matter accumulation in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 145, 23 and 47 percent.

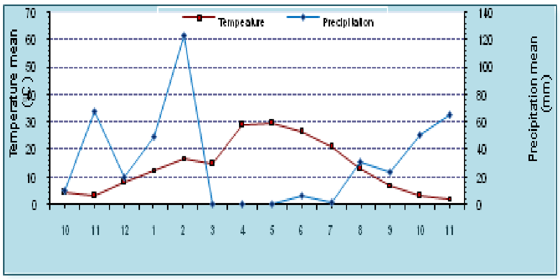

Fig. 1. Temperature curve and the amount of precipitation in 2011-2012.

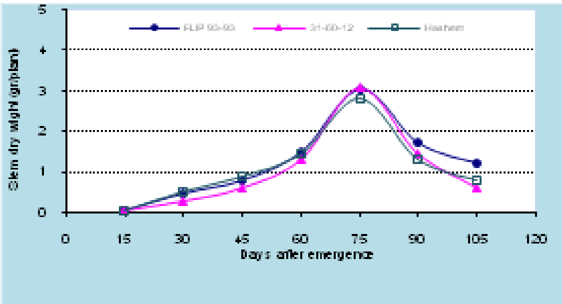

Fig. 2. Stem dry matter accumulation process in different cultivars in delay cultivation.

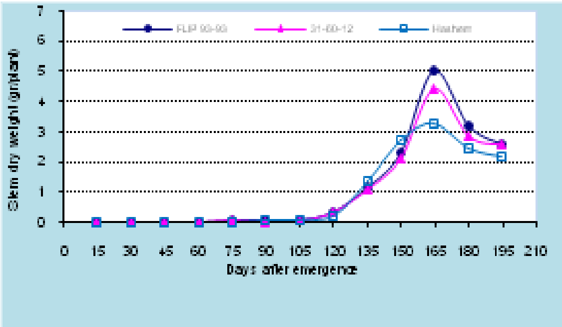

Fig. 3. Stem dry matter accumulation process in different cultivars in fall cultivation.

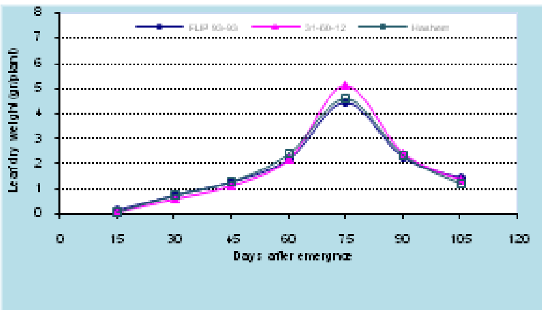

Fig. 4. Leaf dry matter accumulation process in different cultivars in delay cultivation.

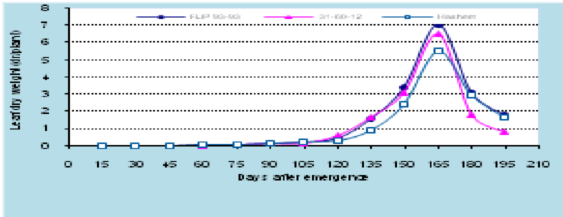

Fig. 5. Leaf dry matter accumulation process in different cultivars in fall cultivation.

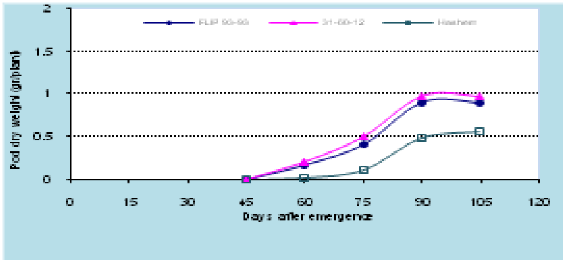

Fig. 6. Pod dry matter accumulation process in different cultivars in delay cultivation.

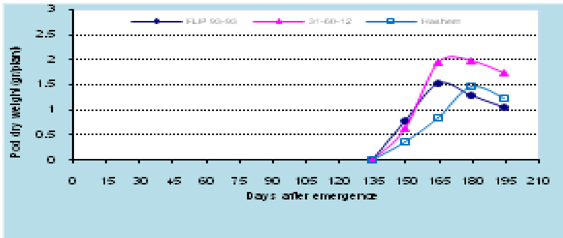

Fig. 7. Pod dry matter accumulation process in different cultivars in fall cultivation.

Plant height

Cultivation date showed the significant difference (1%) there were not significant differences between cultivars and plant height (Table 2). The maximum plant height is related to 12-60-31 and the lowest is related to Hashem. Delay cultivation rather than fall cultivation. had the 46.52 plant height reducing that showing the superiority of fall cultivation to delay cultivation (Table 3). Delay cultivation due to shorten the period of plant growth, reducing the soil moisture, caused to reduce plant height, as a result of this plant had less potential for the flowering production and vegetative growth. Also grains had the less share of storage material retransfer in reproductive organs in delay cultivation rather than fall cultivation. Vaghar, 2007 has reported similar results. The interaction effect showed that 12-60-31 fall cultivation had the most, and in delay cultivation had the least plant height (Fig 12). Reducing the plant height in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 21, 91 and 28 percent.

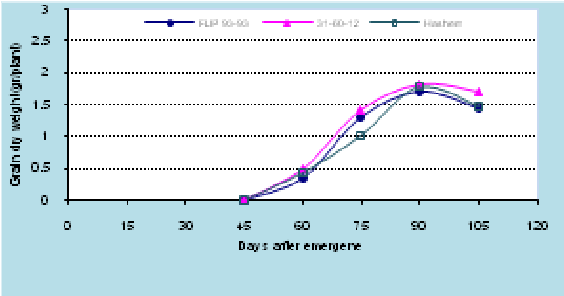

Fig. 8. Grain dry matter accumulation process in different cultivars in delay cultivation.

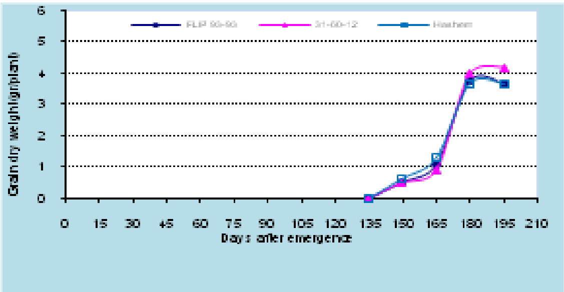

Fig. 9. Leaf dry matter accumulation process in different cultivars in fall cultivation.

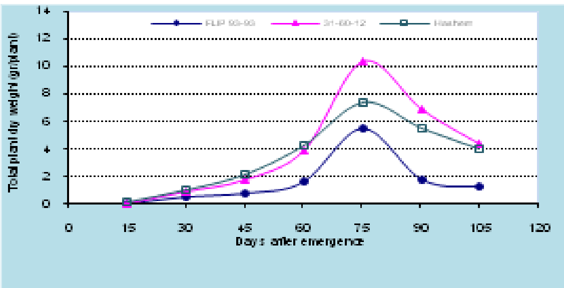

Fig. 10. Total dry matter accumulation process in different cultivars in delay cultivation.

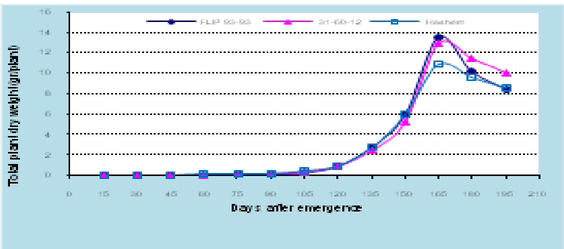

Fig. 11. Total plant dry matter accumulation process in different cultivars in fall cultivation.

100-Seed weight per plant

Among the cultivation dates and in seed weight showed the significant difference at 1% level (Table 2) Delay cultivation rather than fall cultivation showed 13.9 percent 100-Seed weight reduction (Table 3). The increscent of 100-Seed weight in fall cultivation rather than in spring cultivation is due to prolonging the cultivation period in fall cultivation, which will produce more dry matter accumulation and thus generate more pods and grains per plant. Reducing 100-Seed weight in delay cultivation for the reason of shortening growth period, the plant had the less time for using favorable environmental conditions (Ghorban Zadeh and Nasiri, 2005; Imam and Nihnejad, 2004). The effect of cultivars on 100-Seed weight didn't show the significant differences (Tabel 2). Flip93-93 in fall cultivation had the most, and Hashem in delay cultivation had the least, 100-seed weight. The difference among cultivars in this case is more related to genetic differences. The interaction effect of cultivars and cultivation dates on 100-Seed weight created the significant differences at the 5% level (Table 2). Flip93-93 in fall cultivation was produced the most and Hashem in delay cultivation, was produced the least 100-Seed weight (Table 13). 100-Seed weight reduction in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem respectively were 21, 20 and 6 percent.

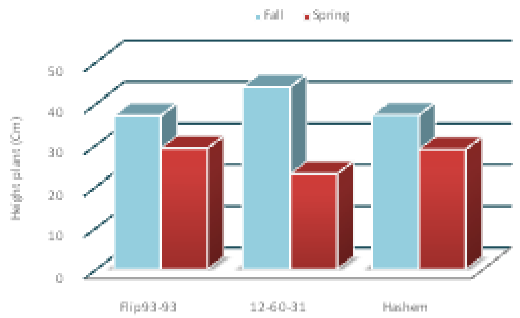

Fig. 12. The effect of cultivar and delay and fall cultivation on plant height.

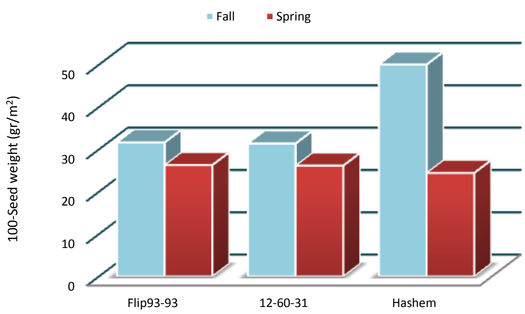

Fig. 13. The effect of cultivar and delay and fall cultivation on.

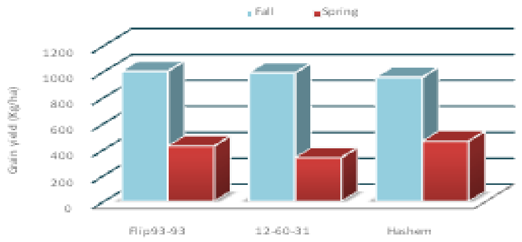

Fig. 14. The effect of cultivar and delay and fall cultivation on.

Grain yield

Grain yield effected significantly (1%) on the date cultivation, that showed the superiority of fall cultivation on delay cultivation of (Table 2). Fall cultivation rather than spring cultivation showed 139 percent yield incensement. Confirmation and early growth in the beginning of the growing season, were caused more usage of environmental favorable conditions and plant yield components are less influenced by water and temperature stress at the end of the growth season. Average comparison showed that Flip93-93 had the most and 12-60-31 had the lowest yield (Table 3). Comparison of the interaction effects on cultivation date and cultivar showed that the highest grain yield belongs to Flip93-93 in fall cultivation and the lowest belongs to 12-60-31 belongs in the spring (Fig 14). The cause of grain yield reduction in delay cultivations is related to low plant height, in low-height plant, reducing the number of pod nodes, reducing the length of the vegetative period, and dry accumulation weight (Mousavi *et al*, 2009; Mahmoudi, 2006). Early maturation trait in dry land areas was caused flowering time and pod is synchronous with the climax heat. In these conditions the vegetative growth period ,especially plant reproductive period is accompanied with a high temperature and by higher evapotranspiration and wasn't obtained proper photosynthesis materials in flowering period and was caused to reduce the yield components and as a result grain yield decreased. But in fall cultivations, low temperature, accompanied with shortening day period prolongs plant vegetative growth, so that active photosynthetic radiation absorption is doing well and is produced more pods. Thus, the number of filled pods increased in per unit area, in fall cultivation which leads to increase the yield rather than delay cultivation. The results match with (Ozdamir and Karadavut, 2003); Hull, (2004); Iliadis, (2001) and Toker and Cogiran, (1998) researches. Grain yield in delay cultivation rather than fall cultivation in Flip93-93, 12-60-31 and Hashem showed respectively 136, 194 and 107%. There are significant and positive correlation among grain yield with the height (r =0.714*), the number of sub branches in per plant (r =0.417*), the number of pods in main branch (r =0.471*), the number of pods in sub branches (r =0.686 *), the number of pods in per plant (r =0.771**), The number of grains in per main branch (r =0.506**), The number of grains in the sub branch (r =0.735**), The number of grains in per plant (r =0.754**), 100-Seed weight on the main branch (r =0.696**), 100-Seed weight in the sub branch (r =0.446**).

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